with gloves for examination, to Messrs. Bayer & Co. for a supply of phisohex, and to I.C.I. (Pharmaceuticals) for a supply of chlorhexidine.

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FALLING ASLEEP OPEN-EYED DURING INTENSE RHYTHMIC STIMULATION

BY

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If one looks at translations of Russian literature in the field of medical psychology one frequently cannot but feel rather lost, for such papers are often couched in terms of the writings of Pavlov.

Pavlov's concepts are not directly compatible with Western neurophysiology, yet, since it is held that those concepts are a guide to therapy and to successful indoctrination, and since, indeed, they have been adopted by Sargant (1951, 1957) to explain sudden political and religious conversion, it is necessary that we should examine Pavlov's writings in order to reconcile them with our own neurophysiological system of knowledge. A partial attempt is made to do so here because the experimental observations with humans to be reported are closely similar to some of the phenomena Pavlov observed in his dogs, and which he believed were manifestations of " internal inhibition " in the cerebral cortex. The " external inhibition " of which he also wrote need not here concern us—it referred to the disorganization of the task in hand by an unexpected and distracting stimulus.

Internal Inhibition

Pavlov was chiefly interested in internal inhibition ; " I shall call it simply inhibition, without the adjective, although each time implying internal inhibition " (Pavlov, 1955, p. 232). This inhibition was evoked in the cerebral cortex by any sensory stimulus to which, from the point of view of the dog's general economy or well-being, it was better that the dog should not respond. Throughout Pavlov's writings we find one recurring clue to the nature of this inhibition which it is possible for us to relate to our own system of knowledge—" internal inhibition and sleep are fundamentally one and the same process " (Pavlov, 1928, p. 307). " We observed that as soon as we applied the inhibitory stimulus, a somnolent state of the animal, in the form of drowsiness or sleep, immediately intervened " (Pavlov, 1955, p. 372) . . . " anyone that makes a thorough study of them will be convinced that inhibition and sleep are one and the same phenomenon " (Pavlov, 1955, p. 375).

Transmarginal Inhibition

One means by which the state of inhibition could be produced was by exposing the dog to certain stimuli which would have evoked a response had they not been excessively intense—" such conditioned stimuli too strong to give the maximal conditioned reflex, Pavlov termed transmarginal or supramaximal " (W. H. Gantt, in his introduction to his translation of Pavlov, 1941, p. 14).

Sargant (1951, 1957) interpreted human reactive collapse, after intense mental tension or excitement, in terms of the " transmarginal inhibition " caused by these transmarginal stimuli. This inhibition was held to be protective, and to be manifest in its effect on behaviour by three distinguishable phases, the " equivalent," " paradoxical," and " ultraparadoxical." These appeared when, respectively, all stimuli, whatever their strengths, acted equally ; when only the weak stimuli had any apparent action ; when the previously elaborated inhibitory agents alone had a *positive* effect. Pavlov wrote of this last, ultraparadoxical, phase as follows: " *In certain stages of drowsiness* [my italics] in normal dogs there occurred a distortion of the effects of conditioned stimuli. The positive stimuli lost their effect, but the negative became positive " (Pavlov, 1928, p. 345). Finally, " after this follows a state of complete inhibition " (Pavlov, 1928, p. 347)—that is, sleep supervened.

It is apparent that not only did Pavlov identify internal inhibition, as most often produced in his laboratory, with sleep, but that the variety he called transmarginal inhibition was believed by him to be of a similar nature

Human Internal Inhibition

In some experiments, described elsewhere (Oswald, 1959), in which electroencephalographic and other physiological variables were recorded, it was found, with larger numbers of human volunteers than it has been possible to use in the experiments to be reported below, (*a*) that signs of sleep appeared in persons subjected to repeated strong electric shocks, (*b*) that signs of sleep could come and go rhythmically in time with regular stimuli at intervals of only a few seconds, (*c*) that signs of sleep appeared while subjects continued to move in time with prolonged, rhythmic music. It is obvious that condition (*a*) could be labelled " transmarginal inhibition," and Sargant (1957) laid great emphasis on the use of prolonged movement, to rhythmic music, as a means of inducing this state of inhibition, quoting with approval the view of Hecker that the state induced is " like that of small animals when they are fascinated by the look of a serpent." This latter condition of fascination, or " animal hypnosis," was shown by Gerebtzoff (1941), and others subsequently, to be electroencephalographically a state of sleep. However, in the experiments with human volunteers mentioned above, the eyes were always closed. Would comparable signs of sleep appear under such circumstances in persons whose eyes were open ?

The example borne in mind was that of a prolonged tribal dance where not only does the individual move in time with the rhythm of the auditory stimuli, so provoking bodily sensations occurring at the same rhythm, but he is stimulated visually, at the same rhythm, by the sight of others moving.

In other experiments, I have encountered some persons who would sleep on undisturbed when their eyes were pulled open during deep sleep beneath a strong light. Again, children may not infrequently be seen asleep with their eyes partly open, particularly during febrile illness. However, it is one thing to be undisturbed by visual stimuli when already asleep, another actually to fall asleep with the eyes open during visual stimulation.

Signs of Sleep

While the most reliable signs of sleep in a normal person are probably electroencephalographic, among other firmly established signs are slowing of the heart (Boas and Goldschmidt, 1932) and pupillo-constriction (Kleitman, 1939 ; Byrne, 1942).

The electroencephalogram (E.E.G.) of the average alert person whose eyes are open tends to be flat in appearance, with some low-voltage fast waves. If he relaxes with eyes closed, the alpha rhythm, at about 10 c./sec., may appear, but it will do so also if he is bored while his eyes are open, and this is probably related to specific visual inattention. As the individual drowses, the alpha rhythm slows and disappears, the E.E.G. record becomes rather flat again, but with low-voltage slow waves at 4–6 c./sec. As sleep deepens these slow waves are accentuated, and, in many persons, bursts or spindles of faster waves at about 12–15 c./sec. are recorded from the anterior part of the scalp. This last state is one of medium-depth sleep. The stage of a flat E.E.G. record with low-voltage slow waves is generally considered to be sleep, and is the stage, above all others, for hypnagogic hallucinations and dreams ; indeed, Dement and Kleitman (1957) maintain that dreams occur only in this stage. The transition from wakefulness to sleep is a gradual and continuous, not an abrupt, discontinuous process.

The Experiments

It was planned that the whole environment of each volunteer should be overwhelmingly (or "transmarginally") dominated by one major rhythm of stimulation. A 60-minute tape-recording of non-stop "blues" music, with the recording on the upper track of the magnetic tape, was played, and on the lower track of the tape there was recorded by hand a sequence of brief 800 c./sec. tones, which went on and off with each succeeding beat of the musical rhythm. A Brenell Mark V twin-track tape-recorder was used for this. In subsequent experimental sessions both tracks of the magnetic tape were played simultaneously, the upper one into a loudspeaker, and the lower one into a transistorized device containing a high-speed relay which closed during each 800 c./sec. tone (which was inaudible, of course). This relay, in turn, was used to actuate other relays which (*a*) switched on and off the mains supply to the visual stimulator (see below), and (*b*) could deliver repeated electric shocks—in both cases at a rhythm *synchronous* with the rhythm of the music.

The Visual Stimulator.—Visual stimulation was provided by four 60-watt electric-light bulbs, one at each corner of a 2 by 2 ft. (60 by 60 cm.) piece of hardboard, which was otherwise featureless except for a couple of brass screwheads in the centre.

Electric Shocks.—These could be provided from a 0.05-microfarad condenser, rhythmically charged to 300 volts, and rhythmically discharged, through the leg of the volunteer, by means of a double-pole break-before-make relay. A 20-kilohm potentiometer, in series, could be used to adjust the severity of the shock.

The Eyes.—The volunteer subjects' eyes were fixed open throughout the experiments, during which a kettle was kept boiling in the room to minimize corneal drying. Rapid-drying collodion was applied, through a fine nozzle, to a narrow strip of the upper eyelid, about 2 mm. from the margin of the eyelashes. The end of a strip of half-inch (1.25 cm.) adhesive tape was applied to the collodion, and further collodion was placed along the line of contact just clear of the eyelashes. When the collodion had dried, the eyes were opened and the upper eyelid was fixed by attaching the free end of the adhesive tape to the forehead with sufficient tension on each side to prevent the lights of the visual stimulator disappearing from the field of vision, even when the subject voluntarily rolled his eyes upwards to the greatest possible extent.

Volunteer Subjects.—They were paid volunteers who were physically and psychologically normal. They had each, in the past, been subjects in experiments involving electroencephalography, and both their waking and sleeping E.E.G. records were known to be unremarkably normal. Three of the subjects worked in an electroencephalography department and one other was an Oxford undergraduate. Needless to say, they had no history suggestive of narcolepsy.

Experiments with Subjects Immobile

Three volunteers were used in these experiments. The subject lay on a couch with the visual stimulator about 2 ft. (60 cm.) above his face, which meant that there was a peripheral visual field containing, among other detail, equipment, curtains, windows, and myself. Stick-on silver electrodes on the scalp (Fig. 1), and arms, recorded the E.E.G. and E.C.G. Two further electrodes, for electric shocks, were placed on the left leg, one over the lateral surface of the neck of the fibula, in order to stimulate the lateral popliteal nerve fairly directly, and a further one over the anterior surface of the tibia a couple of inches away. The passage of the current between these two electrodes stimulated the lateral popliteal nerve sufficiently to cause a sharp eversion of the foot with each shock, so providing rhythmic proprioceptive as well as rhythmic and sharply uncomfortable skin sensations synchronously with the musical rhythm and the light flashes. The music was always very loud.

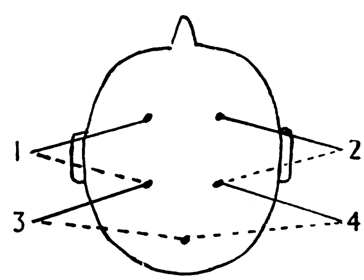

FIG. 1.—Showing positions used for E.E.G. scalp electrodes. The numbers 1–4 in subsequent figures refer to the positions shown here.

Subject A

This subject was a healthy 23-year-old university-educated man who worked in an E.E.G. department. He was very athletic, and his heart rate, when awake at rest, was only 40/min., so that his heart rate of 36–40/min. when asleep did not provide useful information. As this was the first attempt to observe someone fall asleep with open eyes, this one subject was used when deprived of sleep, after less than one hour's sleep the previous night. The experiment was done at 3 p.m. in a shaded room.

Though accustomed to electroencephalography and rhythmic music, he had never before received electric shocks deliberately, nor the flashing lights. Despite this, his E.E.G. showed him to be lightly asleep after 12 minutes, when there was also some eye-rolling, and he remained asleep (Fig. 2)

FIG. 2.—Subject A. Eyes glued open during loud music, rhythmic light flashes, and electric shocks. He rapidly went to sleep, characterized by slow waves and 14 c./sec. spindles in his E.E.G., as illustrated. The large spike artifacts in both the E.C.G. and E.C.G. channels occurred as the lights went off; half-way between each of these a small artifact is visible in the E.E.G.—the moment of the shock and the oncoming of the lights.

for the next half-hour, with only intermittent arousal, due to faults in the apparatus which sometimes caused a double electric shock with a consequent break in the rhythm. The session was then ended. His pupil had been noted to be very small while he was asleep, during most of which time he eyes remained motionless in what appeared, from an oblique view, to be the mid-position.

He declared afterwards that he was aware of having been asleep and of once thinking, "The shocks have stopped," and then realizing that, in fact they had not, but that he had been asleep.

Subject B

This subject was not sleep-deprived, and, though the experimental session was held between 9 and 10 p.m., this was several hours before his usual bedtime. He was a 24-year-old Oxford undergraduate, reading psychology and philosophy, a big, hearty, athletic ex-naval officer.

He had been used as a subject in some quite different E.E.G. experiments some months previously, but had never experienced stimulation of the kind used in the present experiments, and complained more about the electric shocks than did the other subjects. As it was evening, the general room illumination was low (one 75-watt bulb 10 ft. (3 m.) from the subject) and the four electric bulbs before his eyes were so bright that at first he declared he could not possibly stand their glare. However, he was assured that he would get used to it in time—and he did. Fig. 3 illustrates the course of events, from the flat E.E.G. record of alertness, through a stage of diminished alertness with return of alpha rhythm, to a stage of drowsiness with low-voltage E.E.G. slow waves (after eight minutes), to unequivocal sleep after another two minutes, though with only a small fall in heart rate, from 72 to 66/min. While he was asleep his pupils were seen to be small, and, seen from an oblique view, appeared central. He was afterwards fully aware that he had been asleep.

Subject C

This subject, a healthy 20-year-old man, worked in an E.E.G. department, and had, some two years previously, received electric shocks in the course of other experiments. He was in no way sleep-deprived, and the experiment was conducted during the afternoon in a shaded room.

The course of events was similar to that with Subject B. He was asleep within eight minutes (Fig. 5), and after a further 15 minutes was aroused by a double shock (caused by an apparatus fault) which destroyed the rhythm. After this he remained drowsy for another 15 minutes till the session ended. During much of the latter period his basic E.E.G. record, as it were, was that of light sleep—that is,

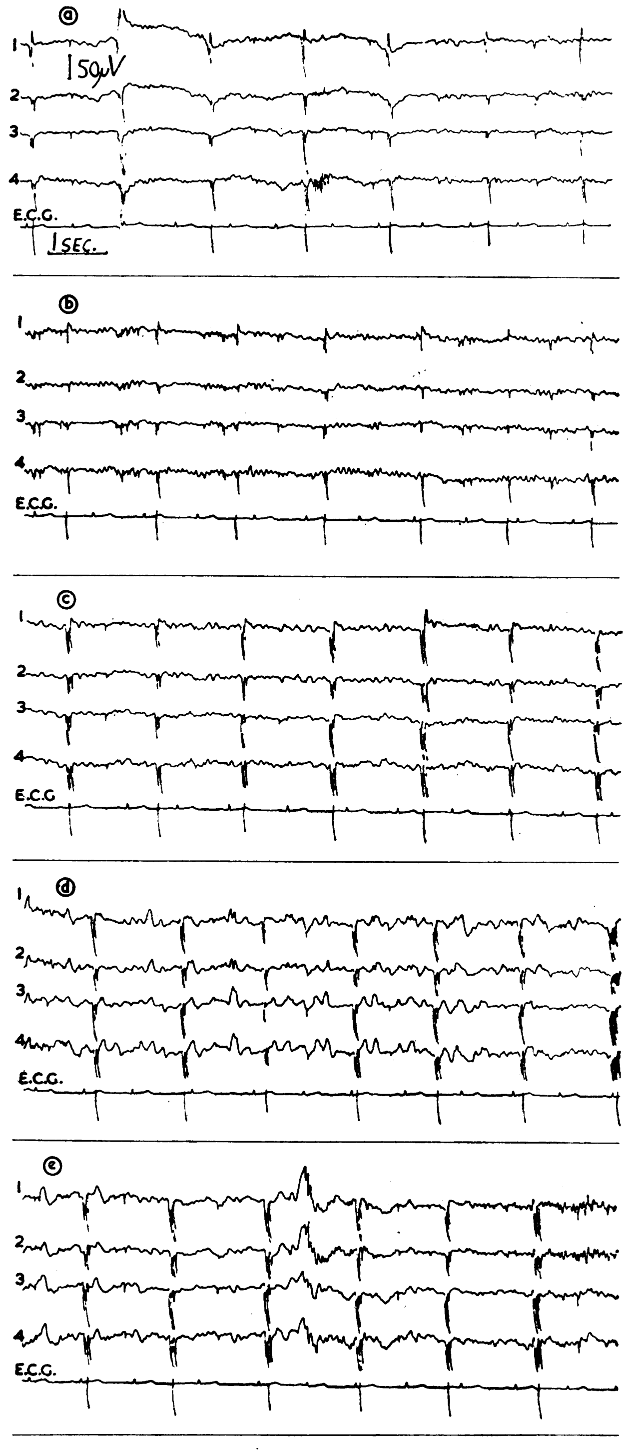

FIG. 3.—Subject B. Eyes glued open. Rhythmic electric shocks and lights. Large artifacts at time of lights off, small artifacts at time of lights on and shock.

(*a*) Top excerpt shows E.E.G. appearance after 1 minute. Note flat record with low-voltage fast waves—the normal appearance in a waking person with eyes open.

(*b*) Second excerpt, after 4½ minutes. Over the back of the head (channel 4 especially) alpha rhythm has reappeared even though the subject's eyes are open.

(*c*) Third excerpt, after 8 minutes. The E.E.G. appearances are now those of very light sleep. The alpha rhythm has disappeared and low-voltage slow waves can be seen.

(*d, e*) After 8 minutes the subject is asleep (bottom two excerpts) and the E.E.G. record is dominated by slow waves and occasional K-complexes appear (the big slow wave followed by 12-c./sec. waves) and anterior 15-c./sec. sleep spindles (channels 1 and 2). His pupil was by now very small.

flat with low-voltage slow waves—but each light flash tended to cause him to alternate between three-quarters of a second in light sleep and three-quarters of a second in a more aroused state in which alpha rhythm was present (Fig. 6).

FIG. 4.—Subject C. Eyes glued open, rhythmic music, electric shocks, and light flashes. After three minutes the E.E.G. record is no longer that of continuous full alertness. The alpha rhythm may be seen, in channels 3 and 4, to appear at times when the lights are off. The big artifacts indicate lights off, the smaller ones indicate lights on. While the lights are on, some 50-c./sec. mains interference occurs.

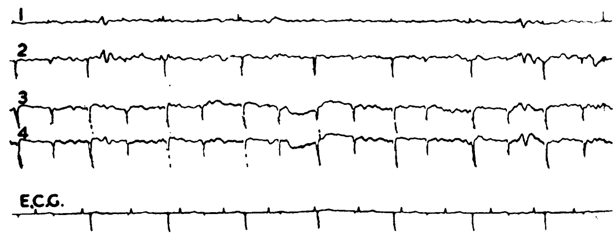

FIG. 5.—As Fig. 4. After eight minutes the subject is lightly asleep and his E.E.G. record is one of low-voltage slow waves. Occasional 12-c./sec. sleep spindles (not shown) also occurred.

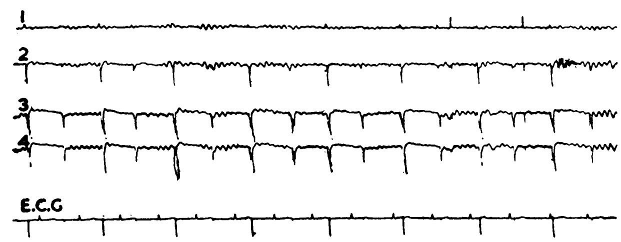

FIG. 6.—As Figs 4 and 5. The subject was aroused by an unintended double shock, and has drowsed since; in contrast to Fig. 4, his alpha rhythm now tends to return when the light is on (during the thick, heavy 50-c./sec. artifact), which rhythmically brings him from, as it were, a state of light sleep to one of low-grade wakefulness

This was in contrast to the first few minutes of the session, when the light had tended to make him alternate between a very alert (light on, no alpha rhythm) state and a less alert (alpha rhythm present) state (Fig. 4).

While his E.E.G. showed signs of sleep, his pupils were seen to be small and rolled upwards, though not sufficiently to obscure the pupils. His heart rate, which had been 80–85/min., fell to 55–65/min.

He subsequently reported that he was quite aware of having been asleep for part of the session.

Experiments with Subjects Actively Moving

The experiments already described involved rhythmic leg movement to the music, but this was really passive movement caused by the electric stimulation. Two further sessions were undertaken in which subjects did not receive electric shocks but actively banged both arms up and down from the elbows, while sitting up in a chair, and tapped both feet in time with the rhythm of the music and the flashing lights.

The visual stimulator was again positioned about 2 ft. (60 cm.) in front of the eyes, which, as before, were glued and strapped fully open. Both sessions took place during the afternoon, neither subject was sleep-deprived, and the room was shaded but not darkened.

Subject C

In the first few minutes his E.E.G. was the fairly flat record characteristic of full alertness with the eyes open, though within seven minutes his alpha rhythm had become fairly continuous and a little slow activity was beginning momentarily to appear. After 10 minutes there came the first break in movement lasting three seconds, and this was associated with the E.E.G. slow-wave picture of light sleep. In the next 15 minutes there were 65 episodes, lasting 3–20 seconds, of failure to move in time to the music, each one associated with E.E.G. signs of light sleep and a considerable slowing of the heart (see Fig. 7). In these episodes of light sleep his eyes were rolled upwards, but not enough to obscure the pupils.

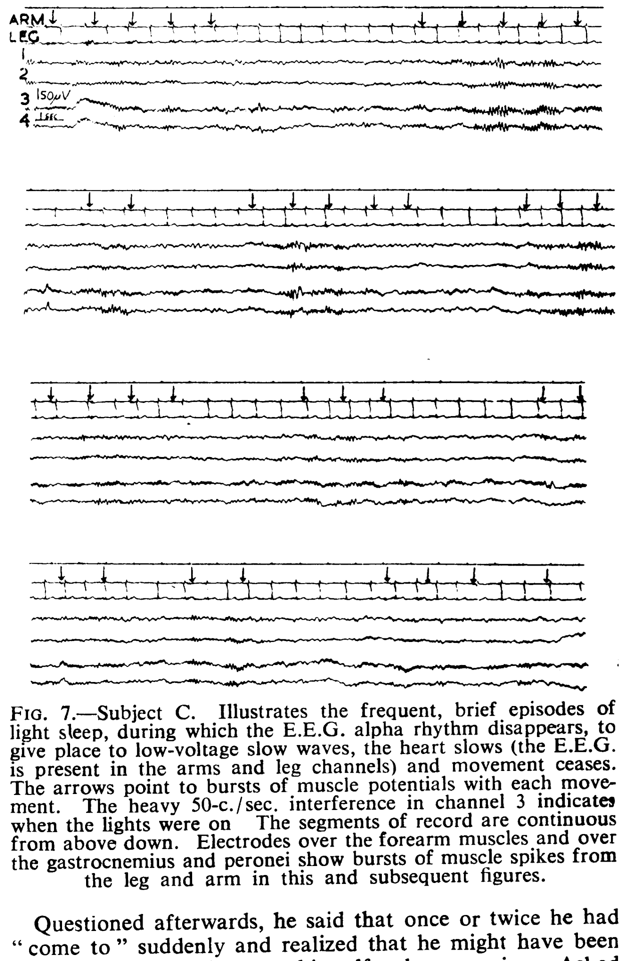

FIG. 7.—Subject C. Illustrates the frequent, brief episodes of light sleep, during which the E.E.G. alpha rhythm disappears, to give place to low-voltage slow waves, the heart slows (the E.E.G. is present in the arms and leg channels) and movement ceases. The arrows point to bursts of muscle potentials with each movement. The heavy 50-c./sec. interference in channel 3 indicates when the lights were on The segments of record are continuous from above down. Electrodes over the forearm muscles and over the gastrocnemius and peronei show bursts of muscle spikes from the leg and arm in this and subsequent figures.

Questioned afterwards, he said that once or twice he had "come to" suddenly and realized that he might have been asleep. He had had to urge himself to keep moving. Asked if he thought he had stopped much, he said, "Yes, but not more than half a dozen times."

Subject D

This subject, a 24-year-old healthy university-educated man, worked in an E.E.G. department. He moved uninterruptedly to the music for 15 minutes, during which time his alpha rhythm gradually became more or less continuously present, after which the first break in arm movement occurred, associated with a few seconds of E.E.G. signs of light sleep. Further breaks in movement, 52 in all, each associated with E.E.G. signs of sleep and usually an obvious slowing of the heart, occurred in the next 25 minutes. Fig. 8 illustrates. The episodes of sleep were associated with small pupils and a variable position of the eyes, which would roll to one side for perhaps 10 seconds, then perhaps upwards (but still with exposed pupil) for a like period, then elsewhere, and so on. The breaks in movement bore no obvious relation to the position of the eyes.

Questioned afterwards, he emphatically maintained that he had stopped moving only once. He said that, at first, luminous geometrical patterns had seemed to be present on the hardboard of the visual stimulator, but later he became unaware of seeing anything.

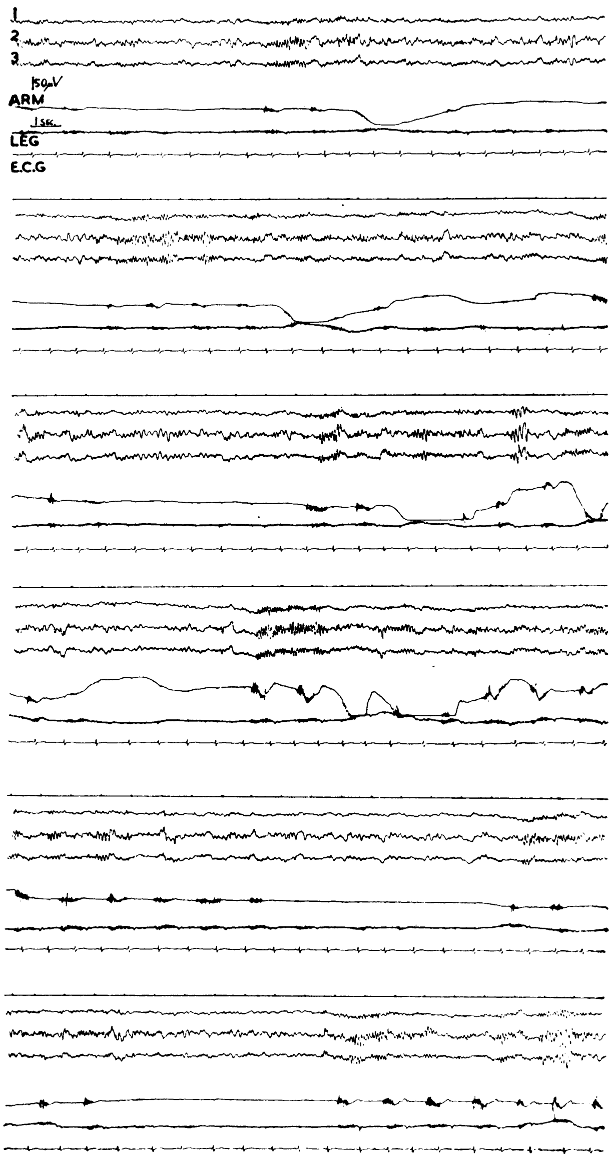

FIG. 8.—Subject D. Eyes glued open while moving actively to rhythmic music and rhythmic light flashes. Illustrating how repeated brief episodes of light sleep were manifested by slow waves in the E.E.G., some slowing of the heart, and failure of movement. Bursts of muscle spikes can be seen to persist longer in the leg than in the arm channel. Just before each return of movement, after a sleep episode, the sleep pattern changes momentarily to a low-voltage fast pattern prior to the alpha rhythm return. The segments of record are continuous. Channel 2 of the E.E.G., in this instance, derived from the front right and the nearmost electrode.

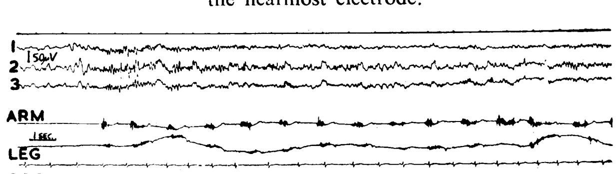

FIG. 9.—As Fig. 8, but to illustrate how, at times, movement continued when the E.E.G. record was, nevertheless, dominated by slow waves.

Compared with experiments previously conducted on volunteers with closed eyes (Oswald, 1959), Subjects C and D tended much more often to cease moving altogether during E.E.G. sleep signs, whereas subjects with eyes closed more often went on moving during similar E.E.G. signs, even though the quality of movement deteriorated. Nevertheless, as may be seen in Fig. 9, there were times when movement continued while the subject's E.E.G. contained a good deal of slow activity.

Discussion

The changes in the E.E.G. seen in the present experiments, which are those characteristic of persons falling asleep under conventional circumstances, were accompanied by slowing of the heart in three of the four subjects, and by obvious pupillo-constriction in also three of four subjects. Furthermore, the subjects in the experiments involving shocks were all quite certain they had been asleep. This was in contrast to the two subjects who moved to the music. The obvious difference between these circumstances was that in the former case subjects slept for minutes at a stretch, while in the latter case subjects appeared to sleep for only a few seconds at a time.

It seems reasonable to believe that each of these volunteer subjects did go to sleep, but it will be remembered, that there is no clear dividing line between wakefulness and sleep, and it is no part of my present concern to insist that subjects crossed any such dividing line, only to claim that there was a considerable fall of cerebral vigilance, and a large decline in the presumptive ascending facilitation from the brain-stem reticular formation to the cerebral cortex.

The eyes of two of the four subjects remained fairly central, and only in one case were the eyes steadily turned upwards. Upward rotation is common, though far from universal, during sleep (Pietrusky, 1922), but Kleitman (1939) noted that if the eyelids were opened and then kept apart during sleep the eyes would sometimes return to the middle position, as I have also seen in other experiments.

The problem which led to the present experiments has already been mentioned—namely, whether intense rhythmic stimulation would produce a sleep-like condition in persons whose eyes were open, for this condition could then be related to the transmarginal inhibition of Pavlov, which Sargant believed developed as a result of intense rhythmic stimulation. The importance of this lies in the differences in the *quality* of thinking between the fully awake state and drowsiness or light sleep. We believe to-day that, other things being equal, fully efficient cortical activity depends upon an optimal, high degree of ascending facilitation from the brain-stem reticular formation. Lesser degrees of that facilitation would be associated with impaired capacity for higher-quality thinking. One of the characteristics of the latter is that numbers of more or less independent facts can be simultaneously related together—in particular, facts derived from the past can be related to current or projected activities or beliefs.

McKellar (1957) has drawn attention to the differences between thinking in the fully alert condition and thinking in light sleep—that is, dreaming—the former "reality-adjusted" thinking, and the latter illogical, "autistic" thinking, which is no longer governed by "repeated appeal and submission to established fact, whether perceived or stored" (Oldfield, 1959).

Autistic thinking in dreams, though illogical, perhaps confused, yet intensely personal, does not quite conform to the "ultraparadoxical" behaviour during drowsiness that Pavlov described, and on which Sargant drew to exemplify, for instance the new love for a formerly hated interrogator, during the state of transmarginal inhibition. Scrutiny of Pavlov's writings, however, leaves some doubt on how firmly established and clearly demarcated were the three phases he distinguished, and even more doubt on how confidently these changes in the salivary secretion of dogs, in the particular circumstances of Pavlov's laboratory, should be extrapolated to human behaviour. It would seem safer merely to recognize that in certain phases of drowsiness the dogs failed to respond in their usual way to stimuli of learned significance, and that the dogs' behaviour became illogical, disorganized, and confused.

The present experiments have illustrated the effects of extremely monotonous sensory stimulation on persons required to *keep still* or make only repetitive movements—the former factor is very important, as discussed elsewhere (Oswald, 1959). Yet there can be little doubt that changes of the same kind, if of lesser degree, must inevitably occur in persons engaged on other monotonous tasks. Apparently trade union opinion was against an unaccompanied driver for diesel locomotives, and one may be glad that the man who has to sit at the front of the train, subjected to its rhythmic chatter, the sight of telegraph poles flashing by, and the rails and sleepers disappearing endlessly below has someone else with him to provide occasional conversation—in fact, to introduce some variety, and help to prevent a state developing similar to that seen in Subjects C and D, who, though aware only occasionally of "coming to," yet went to sleep so frequently.

What physiological mechanisms underly this response to monotony ? Let it be accepted that the degree of wakefulness/sleepiness depends on the level of excitement of the activating system in the brain-stem reticular formation, and the amount of consequent ascending facilitation from it to the cortex. Let it be accepted also that that activating system is kept excited by impulses arriving either directly or indirectly as a result of stimulation of sense organs. If the impulses were to become repetitively monotonous, what would be expected to happen ? There is every reason to suppose that the usual response—namely, excitement of the activating system—would no longer appear, for this phenomenon of *habituation*, or cessation of response on repeated stimulation, is a property of stimulus-response mechanisms of all degrees of complexity (Humphrey, 1933; Oldfield, 1937). Characteristic of this failure of response is the immediate restoration of response, or *dishabituation*, following a change such as an alteration in the rhythm of stimulation—and in the present experiments the arousal reappeared on several occasions when an unintended double electric shock was given.

Hugelin and Bonvallet (1957) have presented evidence to indicate that cortico-fugal impulses can damp down the activating system in the brain-stem reticular formation. In the case of a person who is obliged to keep still and who knows he can do nothing about the sensory stimulation, perhaps inhibitory, "Keep still ! Don't move ! " signals from cortex to brain-stem might well play a part in causing sleep, as is presumably the case in the rabbit fascinated by the snake.

Summary

Pavlov wrote of the basic identity of sleep and states of inhibition caused by certain forms of sensory stimulation.

Experiments are described in which male volunteers, whose eyes were glued widely open, went rapidly to sleep during simultaneous, *synchronized*, rhythmic electric shocks, loud rhythmic music, and strong flashing lights. Active rhythmic movement to the music, in place of the shocks, also appeared to cause subjects to sleep very briefly for a few seconds at a time, often with moments of failure to move in response to the rhythmic music—moments of which the subjects were subsequently largely unaware.

The significance of these observations is discussed in the light of Sargant's proposals concerning "transmarginal inhibition" in humans, and attention is drawn to the failure of "reality-adjusted" thinking in states of light sleep, and also to the almost inevitable occurrence of similar brief episodes of light sleep in persons, such as some drivers, who are exposed to prolonged, monotonous sensory stimulation.

I wish to acknowledge the encouragement and facilities given me by Professor R. C. Oldfield, and to pay tribute to the fortitude of the volunteer subjects. Mr. P. G. M. Dawe kindly made the transistorized high-speed relay device.

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In its Tenth Report the W.H.O. Expert Committee on Addiction-producing Drugs recommends that eight new substances derived from different chemical groups and all having morphine-like effects should be subject to international control—allylprodine, benzethidine, furethidine, levophenacylmorphan, metazocine, norlevorphanol, phenazocine, and piminodine. The committee feels that the fundamental criterion for the establishment and degree of control is the extent to which drug-induced behavioural disturbances are a risk to the community, for neither the chemical structure *per se* nor any definition, however descriptive, can be a complete guide to which substances should be placed under control. It strongly urges that research on drug addiction should be strengthened and expanded, since it continues to be a serious international public-health problem. (*World Health Organization: Technical Report Series*, 1960, No. 188. Available from H.M.S.O., P.O. Box 569, London, S.E.1, price 1s. 9d.)